RANKING URBAN AVIFAUNAS (AVES) BY NUMBER OF LOCALITIES PER SPECIES IN SÃO PAULO, BRAZIL

Edwin O. Willis [1]

ABSTRACT

A new method of zoogeographical analysis is proposed, ranking each species by total number of locality records (L) statewide or in other large regions. The simple analysis avoids the usual practice of giving the same value (n = 1) to a common sparrow and rare eagle. Areas with few low-L species and many high-L ones, as avifaunas of urban parks of São Paulo State, Brazil, are less important in conservation than areas outside cities.

KEYWORDS. Aves, conservation ranking, São Paulo, urban areas, zoogeography.

INTRODUCTION

As city and suburban areas increase horizontally and vertically (tunnels, skyscrapers), parks and even trees tend to disappear. The small and modified green areas that remain are rarely what ecologists were proposing when they suggested "Several Small" instead of "Single Large" refuges ("SLOSS"), or modified this idea (Mccullough, 1996; Hanski & Gilpin, 1997) to suggest possible "metapopulation" movements of fauna or flora among scattered small refuges. Nonbiologists can be optimistic even if refuges are vanishingly small, suggesting that birds and other organisms can "survive" amid scattered bits of vegetation. In Brazil, a major television channel filmed vagrant birds lost in São Paulo City and claimed repeatedly that "as aves estão voltando para as cidades" (birds are returning to the cities). No studies were made, however.

Some studies in temperate zones have claimed that fair numbers of invertebrates, plants and birds survive in gardens (Owen, 1991; Miotk, 1996). These two authors report 48-49 species of birds, but do not analyze conservation status of the species. Presence of House Sparrows *Passer domesticus* (Linnaeus, 1758) would scarcely justify maintenance

1. Departamento de Zoologia, Universidade Estadual Paulista, Cx. Postal 199; CEP 13506-900 Rio Claro, SP, Brazil

of these areas, for instance. Moreover, the authors did not check if birds recorded were mere vagrants or individuals that did not nest or survive, so their gardens may have been "sinks" (PULLIAM, 1988) that aided conservation little or not at all.

Southward, notably in Brazil, some ornithologists share this "birds adapt to gardens" or "metapopulational" optimism; reports of up to 141 species in city parks and on college campuses seem frequent (OLIVEIRA, 1987, 1995; NEUBERGER, 1992; HÖFLING & CAMARGO, 1993; SOUZA, 1995). Outside the tropics, even in Argentina, there seem fewer studies in cities; perhaps dense and dark fast-growing vegetation outside cities is difficult to enter in the tropics, or requires travel funds? Like the northern gardeners, these authors did not analyze their species lists.

Looking over lists, based on my studies of São Paulo birds in some 300 localities since 1975, I got the impression that many urban species from the state were common "supertramp" (DIAMOND, 1975) or "trash" species (in birdwatching language). The literature did not provide a method for systematically analyzing this idea, however. One normally sees simple totals or lists of species, mixing common with rare birds, at times indicating "vulnerable" or "rare" species. Even low counts per hour at one place do not indicate whether a given species is only locally rare or not. Earlier (WILLIS, 1979), I had shown that birds of small woodlots are normally subsets of species lists from successively larger woodlots. This idea led to "nested subset" analysis of species (for instance, ATMAR & PATTERSON, 1993), a method that still did not check the conservation value of species other than a few rare ones - present only in the largest habitat tracts.

Here I provide a simple method to rank each and every species on any local list. One needs only count the number of regional or atlas-based localities ("L") for each species to get an idea of whether it is important in conservation or not. A species with few locality records is more important in conservation efforts than one with many localities, and becomes more important as it disappears from one locality after another. This is somewhat like the idea of "endemic" species versus "non-endemic" ones, where one compares one locality with 2 or more. One could easily talk of "3 -country" birds, but this is not done; even monkeys count better than this (BRANNON & TERRACE, 1998). However, the general ideas of "rarity" and "limited distribution" are certainly based on "few" versus "many" locality records, and analyzing numbers of localities per species is a logical step forward.

I analyze the state and city records from São Paulo, and compare them with nearby lists from city borders, woodlots near urban areas, and even lists of birds collected early this century and the last. Specifically, I look at the median number of locality records for all species at a given locality, and "rare" species (0 - 20 locality records per species in my own studies over the state). Based on this analysis, I suggest that city areas are probably not important for bird conservation; and that such high-priced areas could be exchanged for larger and more important areas elsewhere. I do propose further studies of other organisms, and of other possible values of city green areas.

MATERIAL AND METHODS

My censuses of São Paulo birds ranged from 1 to several hundred hours per locality, in 300 localities, 1975 to 1998. Censuses were "transect" counts, recording birds seen or heard while walking or waiting. Large areas were divided into two or more localities (up to 1000 -1400 ha each), if I normally traveled by car between them or censused on different days. Cities, suburbs, sugar cane and other fields, or pastures, were

seldom checked; this results in underestimates of widespread human-associated species. However, most large forest tracts in coastal mountains were only censused locally, compensating to some extent.

Number of São Paulo localities ("L") where I myself recorded each species. Species with similar "L" numbers are divided, for certain comparisons, in groups of 10 or 30. Museum and literature records are not used for "L" numbers, but are used for local lists of species. I personally checked specimens at the Vienna and São Paulo museums, with the help of curators.

RESULTS AND DISCUSSION

Widespread or "high-L" species in São Paulo (tab. I) are led by the Greater Kiskadee (*Pitangus sulphuratus*, Tyrannidae). Most of these species, or barely different relatives, are common birds to Mexico or Panama. Nearly all are birds of semi-open zones or "edge habitats". The median for 745 nonmarine species in the whole state (tab. II), when one includes 78 species recorded only by other ornithologists, is L = 18 (for instance, the northern migrant Cliff Swallow *Petrochelidon pyrrhonota* (Vieillot, 1817). For L = 1 to 30 localities, 212 species are L = 1-10, 111 are 11-20 and 75 are 21-30. However, not all species recorded at edges of the state occur in the central region near the localities discussed below. If one excludes 142 species found mostly in dry northwestern woodlands or coastal mangroves, beaches or lowland forests, the median rises to L = 23 (for instance, the Buff-fronted Foliage-Gleaner *Philydor rufus* (Vieillot, 1818), with 138/91/64 species in the above L = 1-30 range (and 52 of L = 0).

For comparison with city lists, some lists from nonurban or suburban sites in the region were analyzed (tab. II). About 1820, the Austrian naturalist Johann Natterer and co-workers (Vienna Museum) collected nearly 340 species in savannas, forests and cleared areas around iron mines at Ipanema, just southwest of other areas in tab. II. The median for this collection is L = 38 (for instance, the woodpecker *Campephilus robustus* (Lichtenstein, 1819). In woodlots and natural prairies of Ipiranga, next to São Paulo and now part of the city, the São Paulo Museum (Museu de Zoologia, Universidade de São Paulo) collected nearly 200 species from 1900 to the present (median L = 51). In Ipanema, 66 species were L = 0 to 10 while, in Ipiranga, there were 29.

In secondary woodlands and open areas on a mountain range (Serra do Japi) near São Paulo (Silva, 1992), and on a university campus at the semi-natural edge of the town of São Carlos inland (Motta & Vasconcellos, 1996), ornithologists have recorded totals similar to Ipiranga, but with higher median "L" (73) and fewer rare species. At Broa, an Ipiranga-like natural prairie with gallery woods near São Carlos, I have recorded many more rare species (30 species of L = 0 -10 rather than 2 at São Carlos and 2 on the Japi range) and a lower median "L" (63).

At a 250-ha forest reserve in suburban Campinas, a city midway between São Carlos and São Paulo, 40 species have disappeared in the last 20 years as the city has spread around it (Willis, 1979; Aleixo & Vielliard, 1995), and the median L is now 95. In 1996-98, I recorded birds at a house in a nearby suburb (lawns, scattered trees, houses), noting 97 species, but a median L = 99, and only one bird of L = 1-10 (*Ara nobilis* (Linnaeus, 1758), see below). If one excludes 12 "vagrants" that appeared only briefly or flew over (toucans, parrots, herons), the median L rises to 106 (the introduced House Sparrow, *Passer domesticus*). In the large city of Ribeirão Preto, inland from São Carlos, birds of a large city campus and park (Souza, 1995) range in tab. II, about L = 96 (no birds are L = 0 to 10).

Table I. Birds I recorded at many localities in São Paulo between 1975-1998.

Species	Family	Field localities (L)
Pitangus sulphuratus (Linnaeus, 1766)	Tyrannidae	248
Coragyps atratus (Bechstein, 1793)	Cathartidae	235
Thraupis sayaca (Linnaeus, 1766)	Thraupidae	223
Tyrannus melancholicus Vieillot, 1819	Tyrannidae	219
Cyclarhis gujanensis (Gmelin, 1789)	Vireonidae	211
Buteo magnirostris (Gmelin, 1789)	Accipitridae	209
Troglodytes aedon Vieillot, 1817	Troglodytidae	207
Crotophaga ani Linnaeus, 1758	Cuculidae	194
Stelgidopteryx ruficollis (Vieillot, 1817)	Hirundinidae	193
Columbina talpacoti (Temminck, 1811)	Columbidae	193
Zonotrichia capensis (Müller, 1776)	Emberizidae	193
Volatinia jacarina (Linnaeus, 1766)	Emberizidae	189
Colaptes campestris (Vieillot, 1818)	Picidae	185
Sporophila caerulescens (Vieillot, 1817)	Emberizidae	178
Elaenia flavogaster (Thunberg, 1822)	Tyrannidae	176
Vanellus chilensis (Molina, 1782)	Charadriidae	175
Piaya cayana (Linnaeus, 1766)	Cuculidae	175
Milvago chimachima (Vieillot, 1816)	Falconidae	173
Caracara plancus (Miller, 1777)	Falconidae	168
Furnarius rufus (Gmelin, 1788)	Furnariidae	168
Leptotila verreauxi Bonaparte, 1855	Columbidae	167
Vireo olivaceus (Linnaeus, 1766)	Vireonidae	167
Megarynchus pitangua (Linnaeus, 1766)	Tyrannidae	164
Notiochelidon cyanoleuca (Vieillot, 1817)	Hirundinidae	164
Columba picazuro Temminck, 1813	Columbidae	160
Camptostoma obsoletum (Temminck, 1824)	Tyrannidae	157
Mimus saturninus (Lichtenstein, 1823)	Mimidae	156
Guira guira (Gmelin, 1788)	Cuculidae	155
Saltator similis (Lafresnaye & d'Orbigny, 1837)	Emberizidae	153
Zenaida auriculata (Des Murs, 1847)	Columbidae	151

The first 5 "megacity" localities (tab. II) are from parks in the São Paulo megalopolis (S. Bernardo and Santo André, NEUBERGER, 1992; Planalto Paulista, OLIVEIRA, 1995; Parks, OLIVEIRA, 1987; University of São Paulo, HÖFLING & CAMARGO, 1993). All are fairly close to forest reserves on the coastal mountain dropoff, unlike the interior sites already discussed. However, the megacity sites are definitely within urban zones, rather than close to agricultural/ woodlot landscapes. While city areas have many of the 30 top species in the state (tab. I), the median L values range from 75 (University, Santo André) to 107-8 (Planalto, São Bernardo do Campo).

A few low-L (0-20) species are recorded in megacity or city-edge parks. A vagrant rare dove (*Claravis godefrida* (Temminck, 1811), L = 0) once hit a building on the São Paulo campus and was collected. Woodpecker vagrants (*Campephilus melanoleucus* (Gmelin, 1788), L = 11) of hot and dry northern woods have recently appeared for short periods southward, once near Broa and once on the São Paulo campus, using sunny edges. Other semi-desert suburban species are invading southward with deforestation or have been introduced, and can have low "L" at the moment (the northeastern Brazilian flycatcher *Fluvicola nengeta* (Linnaeus, 1766), L = 13, and African waxbill *Estrilda astrild* (Linnaeus, 1758), L = 19; *Passer domesticus* and *Columba picazuro* seem to have

Table II. Species of nonmarine birds in field locality (L) groups, at São Paulo urban and other interior sites. [a] Museum specimens mostly 1900-1940 (Ipiranga) and about 1820 (Ipanema). [b] Smelly *Coragyps* not collected.

Location	L=0	1-30	31-60	-90	-120	-150	-180	-210	-240	+	Total Species
Statewide	78	398	118	59	46	16	17	8	4	1	745
Region	52	293	107	59	46	16	17	8	4	1	603
S. Paulo megacity:											
1. S. Bernardo	-	2	2	5	3	1	1	3	3	1	21
2. Santo André	-	5	5	9	6	3	2	4	2	1	32
3. Planalto	-	4	11	11	13	5	10	4	4	1	63
4. Parks	-	9	16	18	17	10	12	6	4	1	93
5. University SP	1	22	34	18	27	10	16	8	4	1	141
6. Ipiranga[a]	4	69	44	23	25	16	10	4	3[b]	1	199
Campinas:											
1. Suburb	-	7	18	20	17	7	15	8	4	1	97
2. Woodlot	-	7	28	26	29	14	17	7	4	1	133
Ribeirão Preto	-	11	17	21	25	10	15	8	4	1	112
São Carlos Edge	1	33	51	41	44	16	16	8	4	1	215
Broa Prairie	-	72	39	40	35	16	17	8	4	1	232
Serra Japi	-	28	46	41	38	14	17	8	4	1	197
Ipanema[a]	13	131	80	36	36	15	15	8	4	1	339

completed their invasions).

Migrants and wandering birds explain most other "rare" species, recorded once or twice on certain city lists. A migrant cuckoo from North America (*Coccyzus americanus* (Linnaeus, 1758), L = 13) in Ribeirão Preto and São Carlos, a winter-wandering euphonia (*Euphonia musica* (Gmelin, 1785), L = 8), tanager (*Tangara peruviana* (Desmarest, 1806), L = 10) and fruitcrow (*Pyroderus scutatus* (Shaw, 1792), L = 12), are occasional at city or other edges in the interior. *Dacnis nigripes* Pelzeln, 1856 (L = 8) occasionally appears briefly in migration, as does the rail *Rallus maculatus* Boddaert, 1783 (L = 1). None of these birds seem to have regular summer, migrant or winter populations in urban areas, except *Falco peregrinus* Tunstall, 1771 (L = 3) every northern winter near the São Paulo campus (it hunts city birds from buildings, as noted by ALBUQUERQUE, 1978 and others).

A few rare birds may be more than casual city visitors. The small macaw *Ara nobilis* (L = 3), extirpated at the dry west edge of the state, has escaped from captivity and may breed in Campinas and São Paulo cities, because nest trees cannot be cut down and robbed for cage-bird commerce. It also favors semi-desert open zones, like certain invading species above.

Some ducks hide from hunters on city ponds in São Carlos and São Paulo, even locally rare winter species (Douglas F. Stotz, pers. comm.), much as in northern cities. However, city water tends to be polluted, raising the risk of disease or other problems. Relative rarity of hawks and owls in cities allows wintering martins (*Progne subis* (Linnaeus, 1758), L = 16) to roost in certain inland city parks, foraging over agricultural land (and São Carlos edge) during the day. However, cats and other dangers exist. Flowers and feeders can attract hummingbirds (*Calliphlox amethystina* (Boddaert, 1783), L = 12,

in Santo André and Campinas suburb), and a few even breed in city parks. The swallow-tanager *Tersina viridis* (Illiger, 1811) (L = 56) and other fruit-eating birds sometimes can use planted fruiting trees, notably in São Carlos (LOMBARDI & MOTTA, 1993). However, most such birds are not regular in cities, with few records (tab. II).

In a less disturbed zone, such as the São Paulo region before Natterer, the "trash species" by L-analysis could be native forest or savanna birds. However, edge species tend to be everywhere, even in natural areas, along rocky zones or rivers or disaster areas (windstorms, earthquakes, floods). Natterer found most of the high-L species of today at Ipanema. Moreover, tendencies are for human use of over 90% of state areas, leaving only small and scattered reserves, with avifaunas somewhat like those of urban zones (the Campinas woodlot, Japi and São Carlos sites, for instance). Also, in a region being settled, the temporarily low-L invading species can usually be recognized as newcomers and separated in analyses.

In general, therefore, long lists of São Paulo urban birds are of widespread species, common outside cities. Few rare species breed (except *Calliphlox* and *Ara*?) or have significant winter or migrant populations. City parks, gardens and trees do not seem to aid conservation. Since few persons see a rare bird, one can even question if education in city parks has much effect.

One wonders if other animals or plants show the same urban pattern as do birds. Entomologists, studying very small animals of high or local density, have often rejected the idea of preserving large areas, favoring small and scattered sites. Obviously, a small site in Africa or the Andes and another in distant São Paulo might even preserve more birds; we normally talk about an area or areas within a given habitat and zone, not about areas covering or separated by tens or hundreds of kilometers. Butterflies in Spain, in a recent example (BAZ & BOYERO, 1996), are as speciose in small woodlots as in large ones; the authors seem to indicate that a 2,000 hectare woodlot without differing species could be removed, all one needs are small and scattered woods rather like the parks in the São Paulo megacity.

It is not certain that areas between the Spanish woodlots could be turned into urban zones and still preserve butterflies, but if so, São Paulo city parks could perhaps preserve butterflies or similarly small organisms. However, other students of butterflies report loss of small populations with inbreeding (FRANKHAM & RALLS, 1998) and loss of species in urbanized zones (BLAIR & LAUNER, 1997).

Whether the Spanish or São Paulo butterflies are high-L species or not is uncertain; one would presume that they are, in general, and that most insects are high-L (except certain social insects, as army ants, which disappear rapidly from small São Paulo woodlots; their commensals also disappear, BROWN & FEENER, 1998), because one finds lots of populations and individuals even in a species with restricted range. I strongly suspect that it is rarely necessary to preserve insect species; they can survive in large numbers even in a small park, if these ideas are correct. Thus, conservationists may be correct in worrying more about large species, unless certain insects have only very spotty or limited ranges or fluctuating populations. I doubt that urban São Paulo areas would have low-L insects, even when registering localities at an ornithological scale. Insect localities probably should be very close together, anyway, when comparing populations with those of birds. Studies of these and other animal groups in and outside cities could determine if city parks or gardens really preserve important species.

Populations of plants, especially herbaceous ones, could be preserved in urban parks. However, gardening practices in urban areas tend to emphasize foreign or cultivated species, even to attract hummingbirds (Frisch & Frisch, 1995). It would be interesting to see if someone can eventually prove a conservation reason to preserve city parks and green areas.

It may be that urban parks have some other value for humans, although indoor sports and exercise seem common, while people flock to the most crowded areas possible, even if staying behind closed doors. I suspect that space for lawns, gardens, and even country homes could be better used for agricultural, industrial, commercial, artistic, educational, sporting or residential purposes. If so, one could sell or tax high-priced city and suburban green space and encourage use of the money to preserve more or larger areas outside, while putting green spots atop buildings, tunnel-type streets or houses (see Ando **et al.**, 1998). We would need to avoid excess energy use, by using solar heaters or windows. Conservationists could require that, every time a city park is used for a new road or other facility, that a larger area of equivalent value be purchased elsewhere. Developing corridor zones between reserves might avoid cities spreading together.

In a sense, we are already "modern cave dwellers", and green roofs (or solar heaters) are inevitable. Cities, as they grow, will become as unnatural and species-poor as are multistory city centers today; but, intensive use of city space (concentrating people and their buildings) may even make possible greater preservation of watershed and other areas outside cities. Tourist areas and corridor zones between cities could take care of nature students, while in cities people could encounter activities other than raising large families on big lawns.

Acknowledgments. To CNPq, FAPESP, National Geographic Society, and many land owners, museum personnel, reserve managers, and others, for help. Publication nº 11 of the Institure for Studies of Nature.

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Recebido em 08.04.1999; aceito em 12.08.1999.